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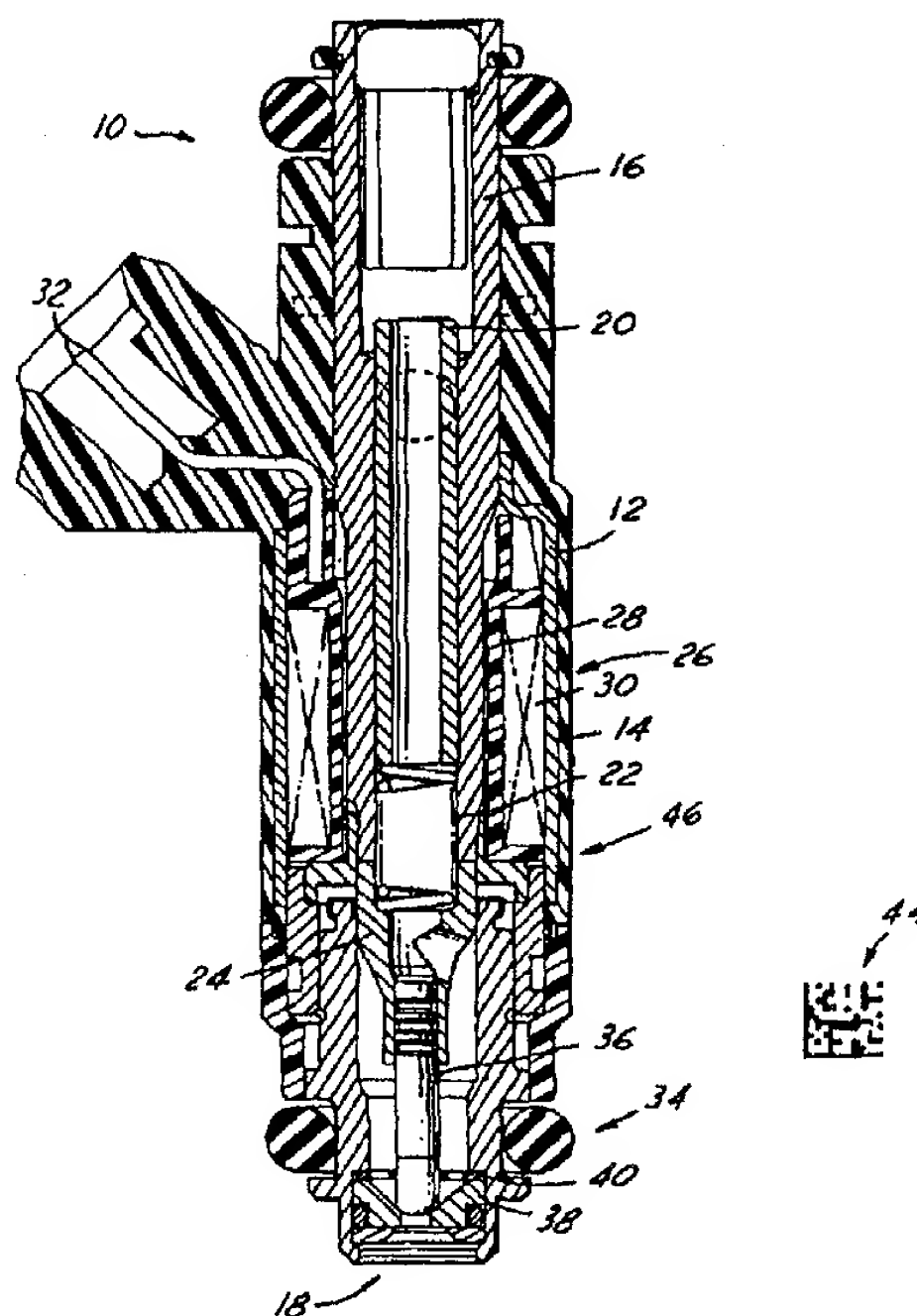
## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(54) Title: BAR CODING FOR FUEL INJECTOR PERFORMANCE DATA

## (57) Abstract

A method for retaining and recalling technical data associated with a solenoid-operated fuel injector (10) improves engine emissions. Each fuel injector is tested to generate technical data specifications relating to the fuel injector. The technical data specifications are then transferred (46) to the fuel injector (10), such as by using a laser marking system to mark the injector with a bar code (44) containing the technical data specifications. The technical data specifications can then be read from the fuel injector such as by using a scanner. The recalled technical data specifications are then provided to a vehicle computer. The vehicle computer adjusts for variations between fuel injectors to collapse variability of injectors to a single, centered injector flow.



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## BAR CODING FOR FUEL INJECTOR PERFORMANCE DATA

Field of the Invention

5 This invention relates generally to electrically operated valves, such as fuel injectors for injecting liquid fuel into an internal combustion engine, and particularly to a method for using fuel injectors to improve automobile emissions.

Background of the Invention

10 The movement of certain electrically-operated valves, such as certain fuel injectors, comprises a needle that is reciprocated axially within the interior of the valve's body in response to electrical energization and de-energization of an electro-mechanical actuator to thereby selectively open and close a flow path through the valve. Fuel  
15 injectors typically contain a solenoid assembly that includes an electromagnetic coil which, when energized, is operative to effect axial movement of an armature.

The state of the art contains a substantial number of patents relating to fuel injector solenoid designs. Typically, a solenoid valve  
20 comprises an armature movable between a first and second position for causing a needle valve to contact and separate from a valve seat. The basic solenoid design includes a coil, a stationary ferromagnetic pole, and the movable ferromagnetic armature. The armature is kept separated from the pole by a force such as gravity, spring, or pressure.

25 Manufacturers of gasoline engines specify in the product engineering specifications the static and dynamic flow rates of a fuel injector. This specification has applied limits typically of  $\pm 3.2\%$  for static flow and  $\pm 3\%$  for dynamic flow. In the manufacturing process, fuel injectors are tested 100% for these characteristics and

those falling outside these limits are discarded. Those inside the limits fit a normal statistical distribution typically displayed as a histogram.

When the injector is assembled into an engine the performance of the injector may be from different ends of the statistical distribution.

5 Although still within the overall specification, this can create variables in emissions of the vehicle. This mixture of rich and lean injectors directly affects the emissions.

10 As governmental standards have become tighter over the years, manufacturers continue to tighten the variability in static and dynamic flows. Industry goals today are in the range of  $\pm 1\frac{1}{2}\%$  for a given population. Tighter tolerances require the internal absorption of higher scrap levels, that ultimately shows itself in product cost.

15 It is seen then that it would be desirable to have a method for providing to a vehicle computer the exact technical data associated with any given fuel injector.

#### Summary of the Invention

20 This need is met by the data retention and recall method according to the present invention, wherein technical test results for an injector are carried with the injector and downloaded to the vehicle computer.

25 Briefly, the invention comprises the implementation of a symbology feature onto a fuel injector. Principles of the invention are of course potentially applicable to forms of fuel injectors other than the one specifically herein illustrated and described and can be accomplished by a variety of data retention and recall means.

30 According to the present invention, a method for retaining and recalling technical data associated with a solenoid-operated fuel injector comprises the steps of testing technical data associated with the fuel injector and transferring the technical data results to the

injector. The injector is then scanned to inform a vehicle computer of the technical specifications of the injector. Variations between injectors can be adjusted for to improve engine emissions.

For a full understanding of the nature and objects of the present invention, reference may be had to the following detailed description taken in conjunction with the accompanying drawings and the appended claims.

#### Brief Description of the Drawings

In the Drawings:

Fig. 1 is a cross section view of a typical fuel injector, having a technical data bar code provided on exterior of the injector in accordance with the present invention; and

Figs. 2A and 2B illustrate two embodiments of the bar coding on the injector of Fig. 1.

#### Description of the Preferred Embodiment

Referring to the drawings, corresponding reference numerals refer to like parts throughout the drawings. In Fig. 1 there is illustrated partly in cross section, a typical fuel injector 10 designed to inject fuel into an internal combustion engine. The fuel injector 10 includes as its major components thereof a housing 12 of magnetically permeable material and an overmold housing 14; an inlet connector 16 in the form of a tube also of magnetically permeable material; an outlet end 18; an adjusting tube 20; a spring 22; an armature 24; a solenoid coil assembly 26, comprising a bobbin 28 and a wire 30; electrical terminals 32 via which the fuel injector is connected with an electrical operating circuit for selectively energizing the solenoid coil; and a valve body assembly 34. The armature 24 is movable between a first and second position for causing a needle valve, or guide pin, 36 to contact

and separate from a valve seat 38, as the pin 36 moves within guide 40.

5 The relative organization and arrangement of these various parts are essentially the same as in the fuel injector of commonly assigned U.S. Patent No. 4,610,080. The injector is of the type which is commonly referred to as a top-feed type, wherein fuel is introduced through inlet connector 16 and emitted as injections from the axially opposite nozzle, or tip, end 18.

10 The differences essentially relate to the inventive features of the present disclosure. Marking products with an identification code has become an essential part of the packaging and manufacturing process in many industries. Ubiquitous bar codes are the most recognizable class of linear symbologies.

15 Referring now to Figs. 2A and 2B, there are illustrated two embodiments of data retention according to the present invention, in the form of a linear bar code and a two-dimensional bar code, respectively. The amount of data a linear bar code 42, such as is shown in Fig. 2A, can contain is limited to a few bytes. In addition, there is often a lack of sufficient area on which to print linear bar  
20 codes. In an effort to overcome these problems, two-dimensional (2D) symbologies 44, such as is illustrated in Fig. 2B, have been developed, which contain information along two axes, not just one.

25 The present invention addresses a method to keep technical test results of an injector, such as static flow, dynamic flow, leak and opening time, with the injector. The data is preferably carried on the injector in symbology form, such as a bar code. The bar code is preferably located on the exterior surface of the injector, such as at location 46, and is cut into the overmold housing 14 of the injector. The data can then be downloaded to any existing vehicle computer

system. The computer system software is then adjusted to improve emissions.

Any given injector, such as injector 10, is tested in manufacturing to provide technical data and specification information relating to that particular injector. A data marking means, such as a laser marking system, may be used to transfer the technical data results and specifications onto the injector, preferably in a scannable form, such as a bar code. The laser cuts the nylon molded surface of the overmold housing, resulting in a series of markings, such as white lines, that are readable with an appropriate scanner. An engine manufacturer can then scan each injector at assembly, thereby informing the automobile computer of the technical specifications of each injector. Associated software then "adjusts" or "offsets" given parameters to accommodate injector specification variations, thereby presenting all injectors as identical to the engine.

The present invention, therefore, provides for a method of data retention and recall, and an "adjust" or "offset" means for collapsing the variability of multiple injectors to a single, centered, injector flow. The injector manufacturing process can have an injector laser marking station to accommodate multiple digits of information. As will be obvious to those skilled in the art, this process is applicable to all fuel injectors.

Having described the invention in detail and by reference to the preferred embodiments thereof, it will be apparent that principles of the invention are susceptible to being implemented in other forms to various injectors and other solenoid-operated valves without departing from the scope of the invention defined in the appended claims.

## WHAT IS CLAIMED IS:

1. A method for retaining and recalling technical data associated with a solenoid-operated fuel injector comprises the steps of:

testing the fuel injector to generate technical data specifications relating to the fuel injector;

5 transferring the technical data specifications to the fuel injector;

recalling the technical data specifications from the fuel injector;

providing the recalled technical data specifications to a vehicle computer;

10 using the vehicle computer to adjust for variations between fuel injectors to collapse variability of injectors to a single, centered injector flow.

2. A method for retaining and recalling technical data as claimed in claim 1 wherein the step of transferring the technical data specifications to the fuel injector further comprises the step of retaining the technical data specifications on the injector as a bar code.

3. A method for retaining and recalling technical data as claimed in claim 2 wherein the bar code comprises a linear symbology.

4. A method for retaining and recalling technical data as claimed in claim 2 wherein the bar code comprises a two-dimensional symbology.



5           5. A method for retaining and recalling technical data as claimed in claim 1 wherein the step of transferring the technical data specifications to the fuel injector further comprises the step of using a laser marking system to transfer the technical data specifications to the fuel injector.

          6. A method for retaining and recalling technical data as claimed in claim 5 wherein the step of recalling the technical data specifications from the fuel injector further comprises the step of using a scanner to read the technical data specifications.

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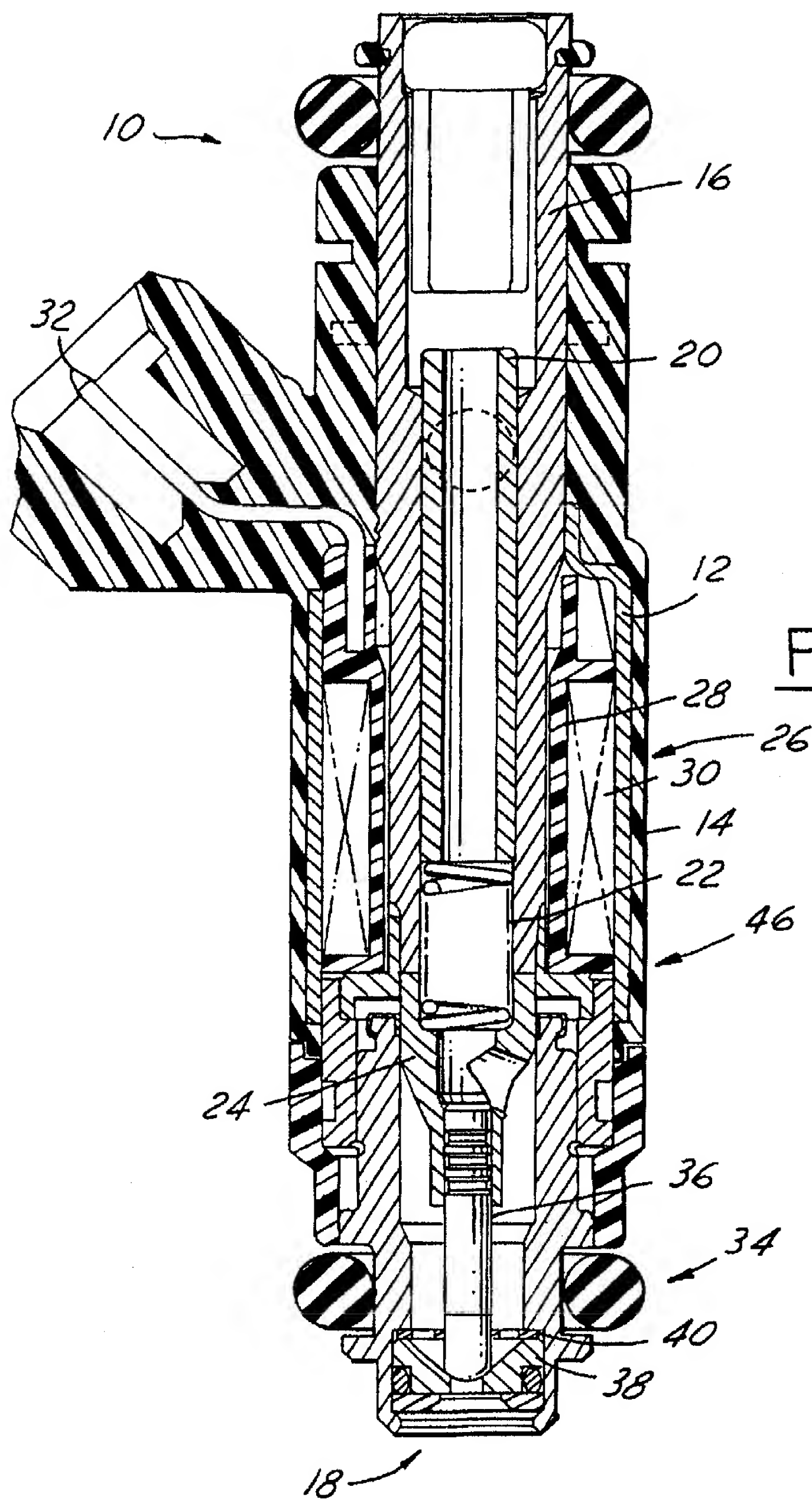


FIG. 1

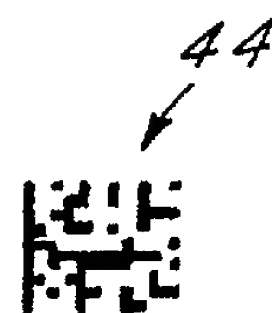


FIG. 2B



FIG. 2A

## INTERNATIONAL SEARCH REPORT

Int'l Application No  
PCT/US 96/18478A. CLASSIFICATION OF SUBJECT MATTER  
IPC 6 F02D41/24 F02M51/06

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 F02D F02M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US,A,4 972 293 (VERNER DOUGLAS R) 20 November 1990	1
Y	see the whole document	2,3,5
Y	--- PATENT ABSTRACTS OF JAPAN vol. 014, no. 434 (P-1107), 18 September 1990 & JP,A,02 170016 (HITACHI LTD), 29 June 1990, see abstract	2,3
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Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 95, no. 009 & JP,A,07 238857 (HINO MOTORS LTD), 12 September 1995, see abstract ---	1
A	PATENT ABSTRACTS OF JAPAN vol. 016, no. 070 (P-1315), 20 February 1992 & JP,A,03 262086 (CITIZEN WATCH CO LTD), 21 November 1991, see abstract ---	4,6
P,X	DE,A,195 20 037 (CATERPILLAR INC) 7 December 1995 see the whole document -----	1,2,6

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A-4972293	20-11-90	NONE	
DE-A-19520037	07-12-95	JP-A- 7332142	22-12-95